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Software Engineering Institute

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CMMI℠ Appraisal Method Overview

GEIA Conference

September 14, 2001

Software Engineering Institute (SEI)

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Agenda – Appraisal Method Overview

Initiating: Requirements, charter, objectives

Diagnosing: Data gathering, analysis, strategy

Establishing: Method design decisions

Acting: Method description, piloting

Learning: Feedback, experience, future plans

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CMMI Appraisal Method Status

V1.0 assessment products published October 2000

- **Assessment Requirements for CMMI (ARC)**
- **Standard CMMI Assessment Method for Process Improvement (SCAMPI)**

Several pilot appraisals performed in 2000 (Phase I) and 2001 (Phase II)

V1.1 primary objectives:

- **Performance improvements**
- **Integrated appraisal method (assessments and evaluations)**
- **Detailed method definition and guidance**

ARC and SCAMPI revisions currently in final stages of development and review

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Performance Goals

CMMI-SE/SW v1.02, ML3 scope.

On-site activities completed within 2 weeks (100 hrs), excluding training and pre-onsite activities

4 projects

SE and SW disciplines

For organizations prepared and familiar with CMMI model and implementation

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Evaluations

DoD sponsor request for integrated CMMI appraisal method

- **Internal Process Improvement (Assessments)**
- **External Supplier Selection and Monitoring (Evaluations)**

Leverage approaches in SCE v3.0 method description and implementation guide

Focus on method; avoid non-technical issues relating to deployment

- **Policy, resources, training, etc.**

Consider evaluation method requirements from DoD / Industry Software Evaluation IPT

CMMI Project
a joint activity of Government, Industry, and the Software Engineering Institute

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January 16, 2001

Dr. Jack Ferguson
DUSD(S&T)SIS
Crystal Mall 3, Suite 104
1931 Jefferson Davis Hwy
Arlington, VA 22202

Dear Dr. Ferguson,

The CMMI Steering Group, and its Assessment Methodology Integrated Team (AMIT), are uniform in their support of an integrated appraisal method for assessments and evaluations. In the interest of maintaining schedule for a Fall 2001 release of the CMMI v1.1 product suite, the AMIT is being directed to focus primarily on the technical issues of such an approach, based on experience with the SCE v3.0 method. The guidance of the DoD/Industry Software Evaluation IPT on requirements for an evaluation method will also be considered.

In an attempt to provide sufficient stakeholder involvement in development of the appraisal method, additional Government representation from the evaluation / acquisition community will be added to the AMIT. However, even this may not be reflective of all interests within the Government evaluation community at large, nor can the AMIT address all issues relative to Government policy or deployment of the integrated appraisal method and the constraints this implies. Therefore, the SCAMPI v1.1 release can be considered a stable method for assessments and a candidate for government evaluations that will be improved upon over time. Additionally, we recommend other means to obtain Government involvement, such as through the Software Intensive Systems (SIS) Steering Group.

Sincerely,

(Original Signed By)
Michael R. Nicol
CMMI Steering Group
Government Co-Chair

(Original Signed By)
Robert C. Rassa
CMMI Steering Group
Industry Co- Chair

CMMI Appraisal

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SCAMPI Method Definition Document

Elaborate the overview method description in v1.0 SCAMPI MDD with detailed method guidance

Clarify method requirements and tailoring

Support appraisal modes of usage

- **Internal process improvement, supplier selection and monitoring**

Target the material to meet needs of multiple audiences

- **Executives, sponsors, appraisal team leaders, appraisal team members**

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SCAMPI v1.1 Development Constraints

Improvements selected for v1.1 must be implemented within available constraints

- **Schedule, staffing, resources, pilots**

Consistent with other components of the product suite (model, training)

Consistent and compatible with ISO/IEC 15504

Respect the investment of v1.0 adopters

- **Stability of product suite**

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Appraisal Method Development Teams

Assessment Method Team (AMT)

- **Developers of v1.0 ARC / SCAMPI suite**

Assessment Method Integrated Team (AMIT)

- **CMMI Product Team members chartered for v1.1 ARC / SCAMPI improvements**

Assessment Method Expert Group (AMEG)

- **Stakeholders from appraisal community**
- **Support AMIT for product development, review, and feedback**

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AMIT Membership

	(Lockheed Martin)	(SEI)
(SPC)		
(SEI)	(Harris)	(SEI)
(USAF STSC)	(Motorola)	(ISD, Inc.)
(Raytheon)	(SEI)	(U.S. Army CECOM)
(USAF ASC/EN)	(TRW)	(SEI)

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Assessment Method Expert Group (AMEG)

(Lockheed Martin)

(USAF / NRO)

(CSC)

(SEI)

(Kasse Initiatives, LLC)

(KAMO Consultancy)

(TRW / FAA)

(SEI)

(SEI)

(Q-Labs)

(SECAT, LLC)

(Raytheon)

(KPMG)

(DCMA)

(ChangeBridge, Inc.)

(Theta Information Systems)

(Alexanna, LLC)

(DCMA)

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Appraisal Method Improvement Sources

Existing appraisal methods and standards

SCAMPI pilots

Community feedback

- **ARC / SCAMPI v1.0 change requests (CRs)**
- **Appraisal method essential characteristics**
- **Appraisal best practices**
- **Performance improvement ideas**

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SCAMPI Method Definition Document (MDD) Transition

SCAMPI MDD v1.0
- Method description

Other Appraisal Methods
- CBA IPI, 731-2
- SCE, SDCE, FAM
- etc.

DoD SW Eval IPT
- Evaluation Requirements Group

Other Sources
- Change Requests
- Performance Ideas
- Best Practices
- Pilot Feedback

CMMI Requirements (Revised)
- A-Spec
- ARC

SCAMPI V1.1

Detailed Method Definition:
- Phases, Processes, Activities
- Inputs, Outputs, Outcomes
- Options

Implem. Guides (v1.1+)

Implementation Guides:
- Internal Process Improvement
- Supplier Selection and Monitoring

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CMMI Appraisal

Essential Method Attributes*

1. Accuracy	**Ratings are truly reflective of the organization's maturity/ capability, reflects the reference model, and can be used for comparison across organizations. Level of confidence that the appraisal results reflect the strengths and weaknesses of the assessed organization; i.e., no significant strengths and weaknesses are left undiscovered.**
2. Repeatability	**The degree to which the ratings and findings of an appraisal are likely to be consistent with those of another independent appraisal conducted under comparable conditions; i.e., another appraisal of identical scope will produce consistent results.**
3. Cost/Resource Effectiveness	**Person-hours spent planning, preparing, and executing an appraisal. A reflection of the organizational investment in obtaining the appraisal results. Includes the resources of the host organization, impact on assessed projects, and the assessment team.**
4. Meaningfulness of Results	**Usefulness of the results (findings) to the organization in establishing improvement initiatives.**
5. Stability of the CMMI Product Suite	**Reflects the relative extent of change… and potential impact on investment by adopters of the product suite. An indicator of evolutionary rather than revolutionary change to the CMMI v1.0 baseline.**

*** Derived from prioritized list of evaluation criteria for the CMMI project (2000) as documented in AI**

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Model Metrics

Release	PAs/ FAs	Goals/ Themes*	Activities/ Practices**
SW-CMM V1.1	6	18	52
316			
SW-CMM V2C	1	19	62
318			
	7	37	156
EIA/IS 731	19	77	383
IPD-CMM V0.98	23	60	865
CMMI V1.0 SE/SW	22	70	417
CMMI V1.02 SE/SW/IPPD	24	76	460

* Ratable components

** Key to implementation effort

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Quantifying the Performance Issue

Model Size (ML3)	**PAs = 18 Goals: SG(41) + GG(18) = 59 Practices: SP(137) + GP(202) = 339**	**• 50% increase from SW-CMM v1.1 • 398 judgments**
Data Items	**339 * 4 * 2 = 2712**	**Assumptions: • 4 projects x 2 data sources**
Est. Data Collection Time	**2712 * 1 minute / 4 mini-teams = 11 hours**	**Assumptions: • 1 minute / data item • 4 mini-teams in parallel**
Est. Consensus Voting	**339 * 4 votes * ½ minute = 11 hours**	**Assumptions: • 4 votes per practice (accurate, corroborated, consistent, sufficient) • ½ minute per vote**

Excludes briefings, interviews, discussion, findings, etc.

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Developing Ideas for Performance Improvement

Analysis of CBA IPI Results

Analysis of CMMI Pilot Results

Community Performance Improvement Ideas

Lead Assessor Best Practices

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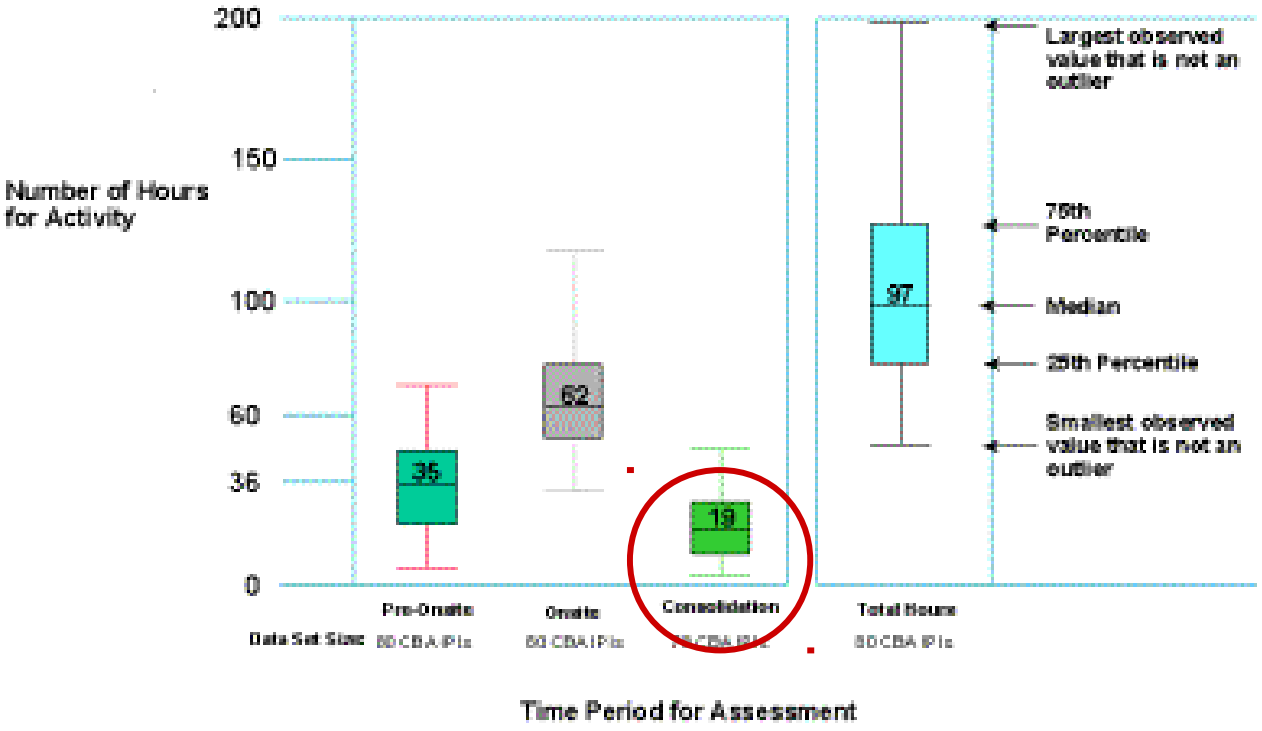
CBA IPI Analysis



Source: "Analysis of Lead Assessor Feedback for CBA IPI Assessments Conducted July 1998 – October 1999", Dunaway, SEI-2000-TR-0005, April 2000.

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CMMI Phase I Pilot Feedback

Total Team Hrs: **(Scaled SE/SW):**	**Min: 90, Median: 128, Max: 144** **Min: 85, Median: 109, Max: 130**	**4 pilots; continuous, CL3/ML3. IPPD (3), Acquisition (3), equivalent staging.**
Team Size:	**6-12 (median = 9.5)**	
Model & Method Issues	**Scope for organization & disciplines not well understood.** **Data gathering and consolidation.** **Difficulty in document review (incomplete, too much, too little, relevance).** **Unfamiliarity with model, method; difficulty interpreting model intent; GPs.**	
Data Gathering	**Redundant questioning across related model threads.**	

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Community Feedback and Best Practices

Method and performance improvement ideas were solicited from the appraisal community (workshops, emails, etc.)

Responses were analyzed, prioritized, and classified for relevant aspects of the appraisal (e.g., method phases, tools, training, guidance, template assets, team practices)

Many of these effective practices and concepts have been incorporated into the v1.1 SCAMPI MDD

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Sample Feedback, Best Practices, Improvement Ideas

Topics	Summary / Examples
Reuse	Validate prior results, reduce rediscovery of earlier proven findings.
Tools	Tool support crucial for data reduction, consolidation.
Observations	Too much time lost crafting observations.
Rating	Rate practices (implemented, partial, not implemented).
Pre-work	Thorough planning. Greater org. readiness. Pre-onsite data review. More effective questionnaire.
Training	Just-in-time training. “Live data”, tools for exercises.
Assets	“Look fors”, templates, checklists.
Tailoring	Provide guidance on mandatory, suggested, optional.

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Appraisal Principles

Start with an appraisal reference model

Use a formalized appraisal process

Involve senior management as the appraisal sponsor

Focus the appraisal on the sponsor's business goals

Observe strict confidentiality and non-attribution of data

Approach the appraisal collaboratively

Focus on follow-on activities and decision-making based upon the appraisal results

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Expectations for Efficient Appraisals

Shared responsibility between the appraisal method, appraisal team, and appraised organization

Thorough planning and readiness

Familiarity with model and organizational implementation

Team efficiency and effective data management

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ARC / SCAMPI Improvement Strategy

Shift appraisal team focus from discovery to verification

- **Leverage pre-onsite analysis of organization model implementation (documentation, mapping, etc.)**

Integrated data collection and continuous consolidation

- **Prioritize areas for remaining investigation based on data collection, analysis, and sufficiency of coverage (i.e., “triage”)**

Provide detailed method definition and implementation guidance

- **Support clarity, consistency, repeatability**
- **Organize content for efficient usage in the field**

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Planned Improvements for v1.1

Appraisal Requirements for CMMI (ARC)

Standard CMMI Appraisal Method for Process Improvement (SCAMPI)

Caveats:

- **ARC/SCAMPI v1.1 development is still ongoing**
- **Planned improvements are subject to review and approval by CMMI Steering Group / CCB**

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Summary of Planned ARC Changes

- **Global replace: assessment to appraisal**
- **Supplier feedback of evaluation results (draft findings, final findings), per Evaluation IPT**
- **Defined appraisal input (a major portion of the appraisal plan) subject to sponsor approval and change control (per 15504)**
- **Greater clarity in Class A, B, C descriptions and relationships in overall appraisal strategy**
- **Revised reporting of appraisal data sent to CMMI Steward (subset of appraisal record, quality and performance data)**
- **Confidence report requirement deleted, intent can be otherwise satisfied (e.g., risks)**

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Characterizing ARC Appraisal Classes

Summary Characteristics	Class A	Class B	Class C
ARC requirements applicable	All	Most	Some
Amount of objective evidence gathered	High	Medium	Low
Ratings generated	Yes	No	No
Resource needs	High	Medium	Low
15504 conformance	Yes (optional)	No	No
Team size	Large	Medium	Small

- Consider a family of appraisal methods in determining overall appraisal needs
- Class A methods may not be the most appropriate choice for organizations early in their process improvement cycle

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What will **not** be in the ARC or MDD?

Form and content of data collection instruments

Tool dependencies

Government acquisition policy related issues.

- **Deployment issues and content described in FAR, RFP, etc.**
- **Reuse of evaluation results (to be addressed by Evaluation IPT)**
- **Source Selection Authority (SSA) interface**

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AMIT Initiatives Investigated

Integrated Data Collection and Validation Approach

- "Triage" Concept - opportunistically use data collection (e.g., questionnaire, objective evidence) to narrow the focus for further investigation and team emphasis
- Leverage organizational assets reflecting implementation of model practices
- Greater appraisal team focus on validation rather than discovery

Incremental Assessments (Deferred post-v1.1)

- Pre-planned partitioning of assessment scope (e.g. PA categories, maturity levels); lower priority than performance improvements

Delta Assessments (Deferred post-v1.1)

- Partial re-assessment to validate incorporation of past deficiencies

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SCAMPI Assumptions and Design Principles

1. SCAMPI is positioned as a Class A benchmarking method.

2. Satisfaction and rating of goals is dependent on the implementation of its related specific and generic practices.

3. The aggregation of objective evidence provided is used as the basis for determination of practice implementation.

4. Practice implementation at the organizational unit level is a function of the degree of practice implementation at the instantiation level (e.g., projects)

5. Assessment teams are obligated to seek and consider objective evidence of multiple types, including face to face interviews, in determining practice implementation and goal satisfaction.

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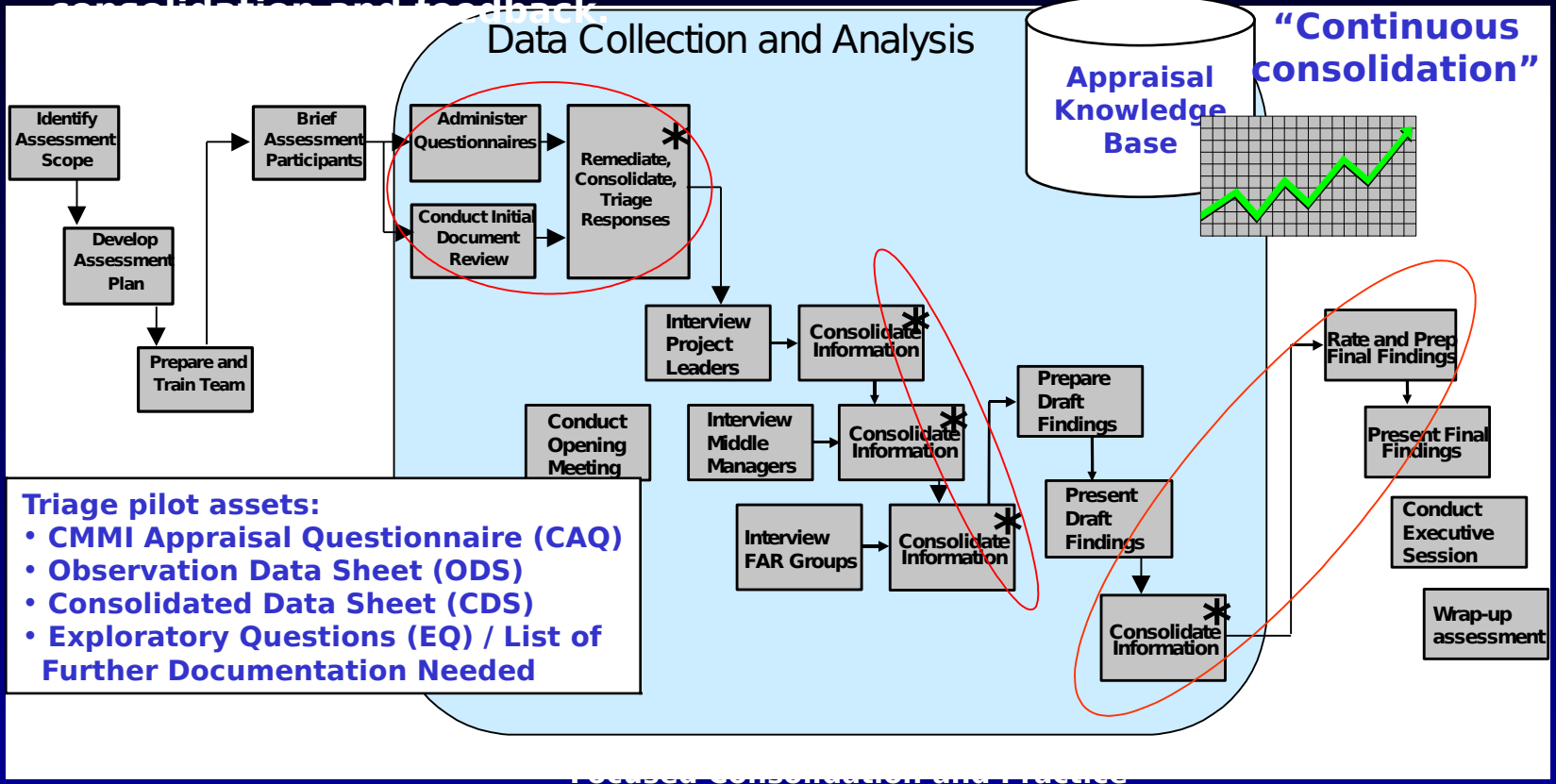
Continuous Consolidation ("Triage")

Triage: analysis of pre-onsite data collection (e.g., documentation, questionnaire responses) to focus further on-site investigation (e.g., interviews) for continuous consolidation and feedback



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Satisfaction

CMMI Appraisal

What are Practice Implementation Indicators?

The fundamental idea of practice implementation indicators (PIIs) is quite simple and broadly applicable to any practice or activity; it is based on the presumption that the conduct of an activity or the implementation of a practice will result in "footprints" which are attributable to the activity or practice.

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Objective Evidence Data Types

Primary Work Products

- Direct, tangible result of a practice (e.g., Typical Work Products)

Indirect Work Products

- Artifacts that are a consequence or indicative of performing a practice (e.g., meeting minutes, reviews, logs, reports)

Affirmations

- Verbal or written statements confirming implementation of the practice (e.g, interviews, questionnaires)

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Example – Indicators of Practice Implementation

PP SP1.1-1:

Establish and maintain

a top-level work breakdown structure (WBS)

for estimating the scope of the project.

Indirect work product:
-minutes of meetings at which WBS was generated or used to develop project estimates

Primary work produ
-top-level WBS, with revision history
-task descriptions
-work product descriptions

Indirect work product:
- project estimates aligned with WBS elements

Affirmation:
- how is the WBS used?
- how are estimates generated?

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Data Collection Sources

Instruments

- **Organizational assets reflecting evidence of implementation of model practices (e.g., mapping tables)**
- **Questionnaires**

Presentations

- **Briefings, demonstrations**

Documents

- **Hardcopy, softcopy, hyperlinks**

Interviews

- **Standard structured interviews; on-call interviews; follow-up interviews**
- **Exploratory of focused questions targeted at practitioners and users**

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Data Collection and Recording

Team member notes

- Tagged to model and data collection sources

Observations

- Inventory of objective evidence for implementation of each model practice, for each process instance
- Strengths and weaknesses (where applicable)
- Reduced crafting of observations

Findings

- Aggregation of strengths and weaknesses

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Characterizing Practice Implementation

Assign characterization values reflecting the extent of practice implementation for each instance

Aggregate practice characterizations to organizational unit level

Iterate and focus revisions to data collection plan

Generate findings based on aggregation of strengths and weaknesses

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Characterizing Practice Implementation – 2

Fully Implemented (FI)	• Primary artifacts present and appropriate • Corroborated by indirect artifact and/or affirmation • No substantial weaknesses noted
Largely Implemented (LI)	• Primary artifacts present and appropriate • Corroborated by indirect artifact and/or affirmation • One or more weaknesses notes
Partially Implemented (PI)	• Primary artifact absent or judged inadequate • Artifacts or affirmations indicate some aspects of the practice are implemented • Weaknesses are noted
Not Implemented	• Any situation not covered by above

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Rating Structure Paradigm

	Level of Consensus
Capability Level and/or Maturity Level Ratings	Full Team
Goal Satisfaction Ratings	Full Team
Practice Implementation Characterizations (organizational unit level)	Full Team
Practice Implementation Characterizations (practice instantiation level)	Mini-Team

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Data Collection and Rating Concepts

Corroboration

- **Must have primary (direct) work products, combined with either indirect artifact or affirmation**

Coverage

- **Must have sufficient objective evidence for implementation of each practice, for each instance**
- **Must have face-to-face (F2F) affirmations (avoid "paper-only appraisals"):**
  - **At least one instance for each practice ("one column")**
  - **At least one practice for each instance ("one row")**
  - **or 50% of practices for each PA goal, for each project, have at least one F2F affirmation data point**

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Affirmation Coverage Rules - Summary

	Project-1	Project-2	Project-3	Project-4	Σ Row
PA.SPx.1-1	✓	✓			✓
PA.SPx.2-1		✓			✓
PA.SPx.3-1	✓		✓	✓	✓
PA.SPx.4-1			✓	✓	✓
Σ Column	✓	✓	✓	✓	

or, 2. "50% rule":

≥ 50% of PA practices for each goal, for each project, have at least one face-to-face (F2F) affirmation data point

1. "One Row, One Column"

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Verification and Validation Techniques

Verification

- Verify implementation of model practices at instantiation and organizational levels
- Populate appraisal knowledge base from organizational assets

Validation and Reporting

- Draft findings
- Final findings

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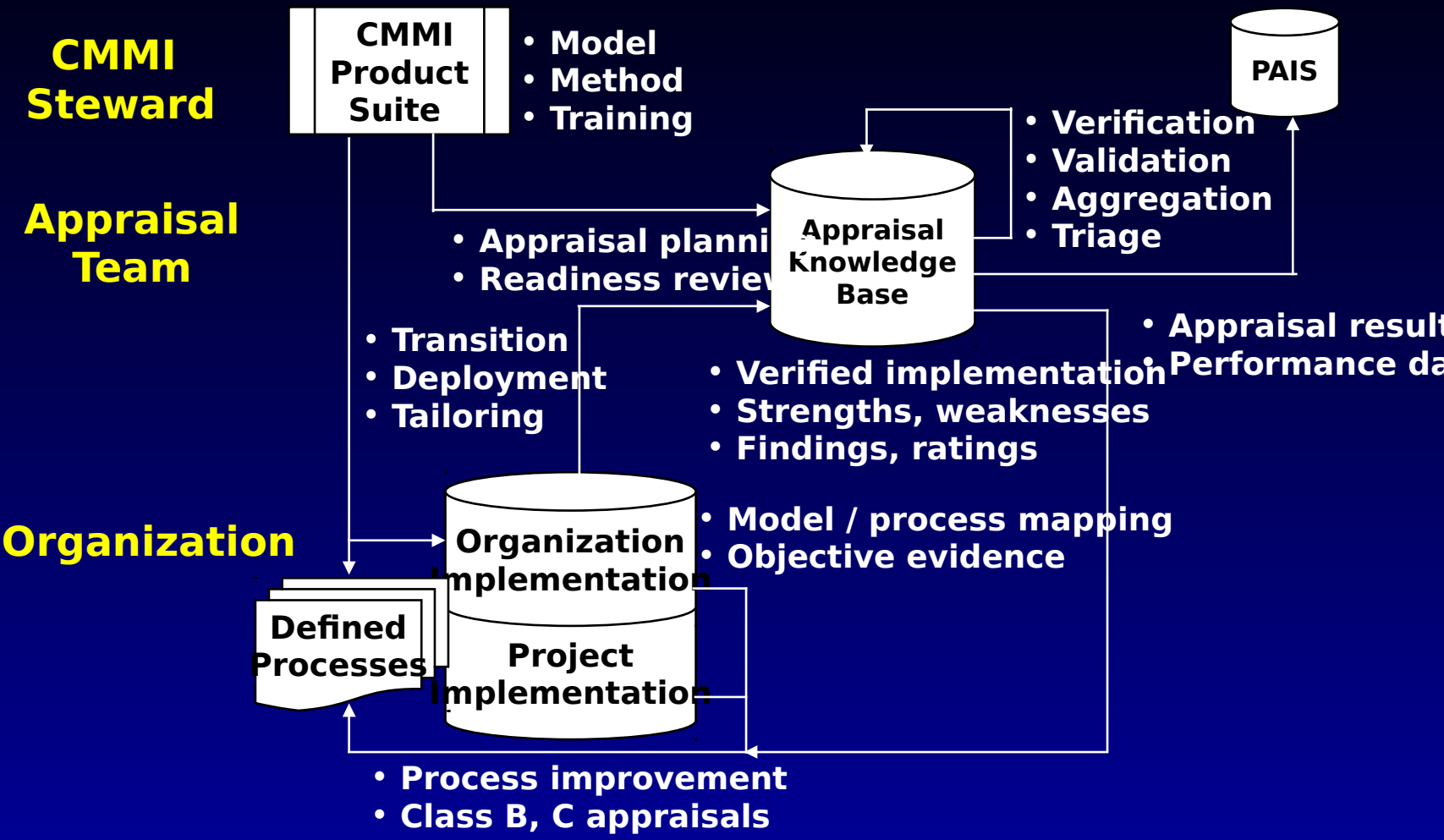
Appraisal Conops



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Tailoring: SCAMPI Implementation Model

The SCAMPI implementation model (SIM) is intended to provide a way of thinking about the various constraints and considerations that apply to the application of SCAMPI to a specific appraisal instance

Lead Appraisers need to clearly understand the "degrees of freedom" they have when planning an appraisal

- **Where can there be no deviation from what is prescribed by the method?**
- **Where can alternative implementations be considered?**
- **Where are there opportunities for customization?**

Why alternative implementations and/or customizations?

- **Adapt method to special circumstances**
- **Exploit opportunities for additional efficiencies**
- **Take advantage of special circumstances**

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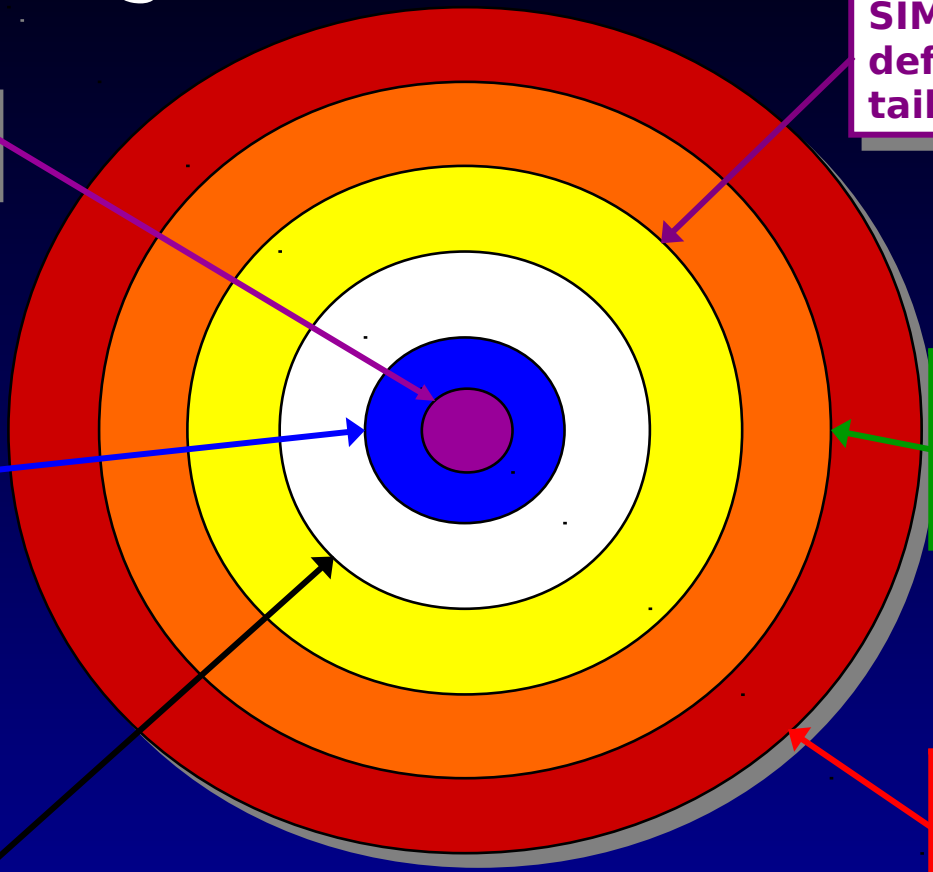
SIM Ring View



SIM0: 15504

SIM3: SCAMPI-defined tailoring

SIM1: Appraisal Requirements for CMMI (ARC)

SIM4: SCAMPI Implementation choices

SIM2: SCAMPI Features

SIM5: SCAMPI Add-ons

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SIM Examples (v1.0)

Method Implementation Feature	SIM Layer				
	1	2	3	4	5
Consensus is used as the decision-making process when determining the validity of observations, creating findings, and establishing ratings	X				
The sponsor and the assessment team leader must approve the contents of the assessment plan prior to conducting the assessment.	X				
A minimum of one assessment team member must be from the organization being assessed.		X			
A process area may be assigned the rating of "partially satisfied"			X		
Process area worksheets (Excel) are used to assist in data collection and validation				X	

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MDD v1.1 Outline (Planned)

Front Matter

Introductory Prose

Executive Summary for the Appraisal Sponsor

Doc. Overview

Part1 Descriptive name and information

Part2 Descriptive name and information

...

Part N Descriptive name and information

Method Overview with audience-specific summary of this document
---

Primary Reference Material

Phase I: Appraisal Planning

Phase II: Conduct Appraisal

Phase III: Report Results

Appendices

Elaborations and Guidance

SCAMPI Implementation Model

Index with key terms and threaded reference trees

Tool kit full of Templates and work aids.

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MDD v1.1 Architecture (draft)

1. Analyze Requirements
2. Develop Appraisal Plan
3. Select and Prepare Team
4. Obtain and Analyze Preliminary Data
5. Prepare for Data Collection
6. Collect Data
7. Record Data
8. Verify and Validate Data
9. Make Rating Judgments
10. Deliver Appraisal Results
11. Package and Archive Appraisal Assets

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Sample MDD v1.1 Format

3.1 Activity 1: Analyze Requirements

Purpose

Understand business needs, objectives and constraints.

Entry Criteria

Sponsor decides to perform an appraisal.

Inputs

Business requirements:	Resource constraints	Logistical constraints
• Business context • Sponsor objectives • Specific sponsor requirements	• Personnel, facility, and project availability • Budget availability	• Program plans • External schedule • Geographic constraints

Activities

1.1. Analyze Requirements
1.2. Determine Goals
1.3. Determine Constraints
1.4. Determine Target Process Capability
1.5. Determine Outputs and Intended Usage
1.6. Obtain Commitment

Outputs

Appraisal requirements
Goals
Constraints
Target Process Capability (TPC)
Rating baseline decision
Appraisal outputs list
Appraisal "Contract" (e.g., Sponsor "sign-off")
Appraisal requirements checklist

Outcome

The decision to proceed with the appraisal, based on a shared understanding of the appraisal goals, constraints and scope.

Exit Criteria

Appraisal checklist – requirements completed.

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Example MDD activity description based on information mapping approach.

MDD processes contain the following, as applicable:

Purpose - Entry Criteria - Inputs - Steps - Outputs - Outcomes - Exit Criteria

Descriptions of activities

Detailed guidance and elaboration

Process monitoring description - tools and techniques - metrics - verification & validation - records - training

Tags and format are used consistently to aid navigation and references.

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SCAMPI v1.1 Infrastructure

Integrated SEI Appraiser Program (assessments, evaluations)

SCAMPI Lead Appraiser Training

Appraisal Team Training

Templates, work aids, checklists

Pilot toolkit (questionnaire, observation worksheet)

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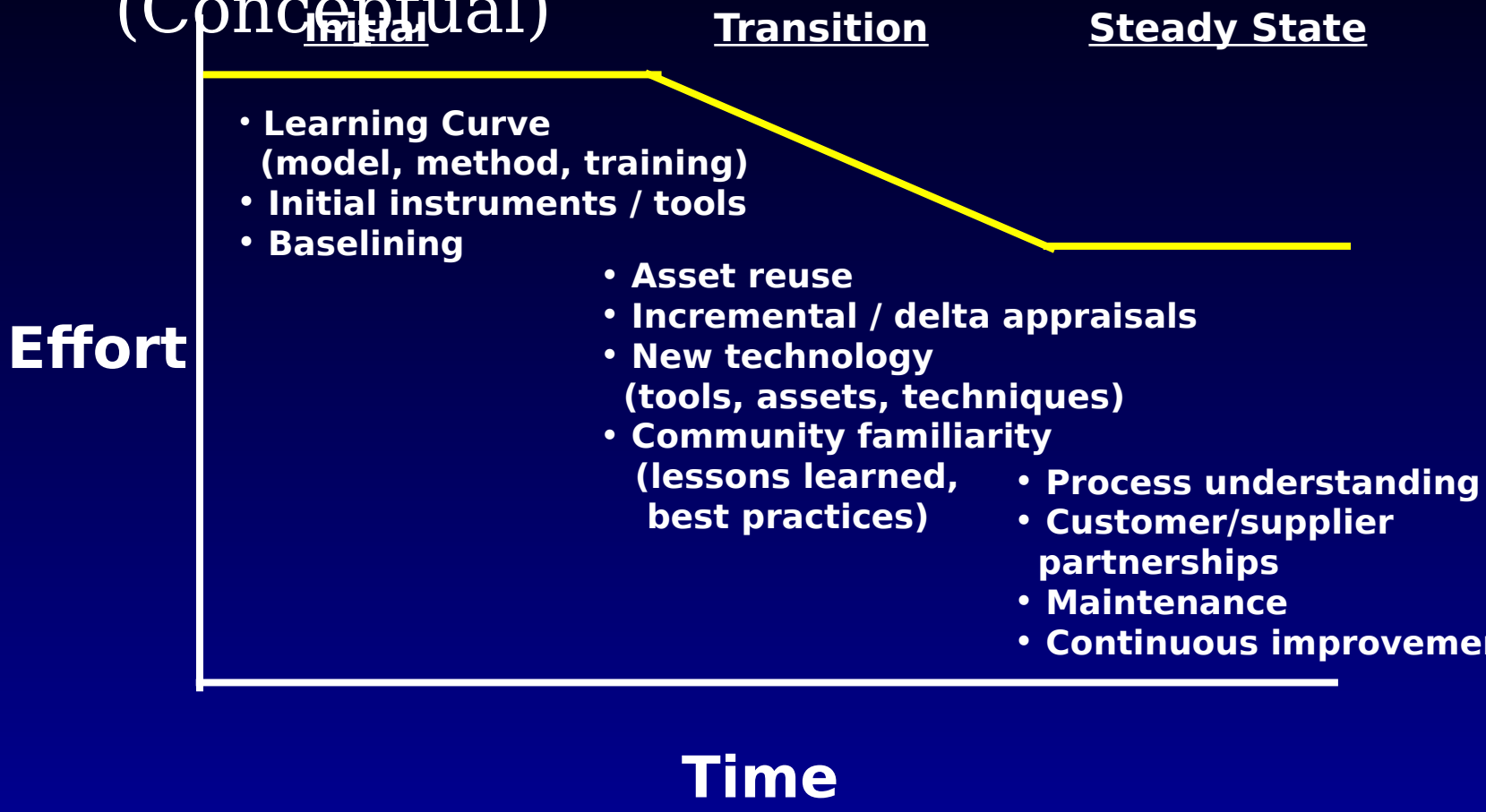
Performance Improvement Curve (Conceptual)



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Potential Future Efficiencies

Incremental and delta appraisals

Additional work aids (templates, checklists, “look fors / listen fors”)

Improved questionnaires

Statistical sampling

Leverage and cross-correlate model built-in dependencies for improved appraisal data management.

- **Relationships (threads) among practices (GPs, SPs), Goals, PAs**
  - **e.g. PP, PMC, IPM**
- **Single work products / indicators that satisfy multiple practices**

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Example – Correlating Indicators Across the Model

SP/GP	Summary	Project Plan	Commit-ments	…
PP.SP2.7	Establish the project plan.	➨		
PP.SP3.3	Obtain plan commitment.	➨	➨	
…				
PMC.SP1.1	Monitor project planning parameters.	➨		
PMC.SP1.2	Monitor commitments.		➨	
PMC.GP2.2	Plan the process.	➨		
…				
IPM.SP1.4	Integrate plans.	➨		
IPM.SP1.4	Manage project using integrated plans.	➨		
…				

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Summary

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CMMI Appraisal Method Status

ARC and SCAMPI v1.1 revisions currently in final stages of development and review

- **Performance improvements**
- **Integrated appraisal method (assessments and evaluations)**
- **Detailed method definition and guidance**

Fundamental SCAMPI concepts

- **Indicator-driven appraisals**
- **Integrated data collection and continuous consolidation (“triage”)**

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Contrasting Appraisal Methods

Appraisal Method Feature	Traditional Methods (e.g. CBA IPI)	Indicator-Based Method
Fundamental Approach / Data Collection Mechanism	Observation-driven (statements)	Indicator-driven (PIIs)
Assessment Team Emphasis	Discovery	Verification
Observation Statements Generated	All strengths and weaknesses	Primarily for weaknesses; avoid crafting “gratuitous” observations for strengths
Team Consensus	Team consensus on observations, findings, ratings determined on-site.	Mini-team consensus on instantiation-level evidence Full team consensus on OU aggregation, findings, ratings
Corroboration	2 sources for observations, 2 different data	Corroboration built into the appraisal data types (primary,

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Topics	Summary / Examples	SCAMPI v1.1
Reuse	Validate prior results, reduce rediscovery of earlier proven findings.	Partial (Org. indicators)
Tools	Tool support is crucial for data reduction, consolidation, etc.	Partial (CAQ, OBS)
Observations	Too much time lost crafting observations.	High (Indicators)
Rating	Rate practices (implemented, partial, not implemented).	High (Characterization)
Pre-work	Thorough planning. Greater org. readiness. Pre-onsite data review. More effective questionnaire.	High (Org. indicators)
Training	Just-in-time training. “Live data” and tools for exercises.	Partial (Tailoring option)
Assets	“Look fors”, templates, checklists.	Partial (Method checklist)

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